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The variability of lateral duction sequence

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TIME VARIABILITY OF LATERAL DUCTION SEQUENCE

By

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INTRODUCTION

A founding premise in clinical optometry is that a Zone of Single Binocular Vison exists for any given patient.[1] The Zone can be further divided into three separate distinct areas. They are, the Zone of Clear Single Binocular Vision, the Zone of Single Binocular Vison and the Zone of Single Recovered Binocular Vision. Clinically, the zone is measured using a set of tests performed when the patient is looking at distance and then at a near point situation.

The actual measurement, that is performed, is the ability of the eyes to make disjunctive eye movements. The most prevalent method of measurement is utilizing the Risley prism mounted on the phoropter or phorometer. From this measurement of the blur or blur out, break, and the recovery of the eye movements a set of prism findings are thus found. These prism findings are either graphed or mathematically treated so as to determine the Zone of the measurement we are interested in, or all the zones can be determined.

The zones and the data derived from them are used to evaluate and analyze the visual function of the individual. The assumption has been made that the zone slope is a constant and nonvariable function. Beyond this, the zone is easily duplicated from one time to another and from one clinician to another.

The assumed nonvariability of the slope of the zone has led to the founding of a group of analysis methods which use the zone as a criterion for successful prescribing.[2,3,4,5]

One problem still exists with this assumption of nonvariability. That is, no controlled studies have been published to prove the constancy of the zone slope.

OBJECTIVE

In the proposed study the variability of the zone will be determined. This variability will be studied from a number of different standpoints. Clinically, the variation of the findings taken within a short period of time must be either significant or insignificant. Either way, the results will be important to the scientific base of the optometric science. Also the variation over a relatively prolonged period of time must be considered for its significance.

METHOD

The experimental design will be limited to the measurement of the break and recoveries with the blurs or blurouts being too variable and subjectively unreliable from subject to subject. In order to analyze the variation of the blur or the blur outs from subject to subject, a criteria would be needed that could be checked and clinically this would be too cumbersome and not feasible. The data will be gathered four times per day, once per week for four weeks. The findings will be analyzed for significant variation either within the same day or over the period of testing. Each week will be compared to the other weeks to determine the differences and their significance.

The Zone of Single Binocular Vision and the Zone of Single Recovered Binocular Vision will be evaluated separately and then as they relate to one another. The Zone of Single Binocular Vision will be

assumed to be synonomous with the Range of Fusional vergence or the Lateral Duction Break Range. The difference in the terms is author specific.

All measurements will be taken on optometry students (3rd and 4th year) because the response and variance in the measurements should be more pronounced if a trained observer is used.

The standard Optometric Extension Program preset and instructions will be used in the measurement of the findings. The same order will be used as is used clinically, that being, measuring at far the Base Out (B.O.) and Base In (B.I.) findings then moving the distance to forty centimeters and measuring the B.O. and B.I. findings.

The validity of the lateral duction sequence is well documented. Many investigators have found norm values with probable error of the measurement from one test to another. Haynes' Pacific University norms show a probable error of 5 prism diopters[6] while Morgan shows a probable error of 3-5 prism diopters depending on the finding. Optometric Extension Program norms were not published with an expected error for the test findings but the norms are in agreement with the norms of both Haynes and Morgan. Other investigators determining norms, probable errors or error analysis had very similar results to both Haynes and Morgan. This suggests the intertest stability is good and correlates favorably, however, none of the investigators cited here or in the bibliography had a study relating the values determined at one particular time as would be related to the value taken at another time some standard unit later.

Studies have shown that a variance occurs in test findings if the time of dissociation or the time taken to measure to zone is changed. Baird (et al)[7] in a Pacific University optometry thesis

indicated the proper time of prism measurement is ~1 sec/ 1^{Δ} of movement both far and near but the effective difference was much more pronounced at near than at far. This is what would be expected. Swanz,[8] in a Pacific University optometry thesis compared the fusional convergence test sequence using a Snellen chart compared to a single line of 20/30 letters at far and a reduced snellen and single line of 20/20 letters at near. In the thesis, he suggested the single line at both far and near were better test procedures.

COLLECTIVE DATA

Subject #1

FAR	MEAN	Std. Dev.	F(time)	F(day)
Bk	23.9	1.1	1.6	0.2
R	15.3	1.4	2.1	0.9
Bk	8.9	0.3	1.7	0.3
R.	4.9	0.4	1.2	3.7
NEAR				
Bk	25.4	0.2	0	3.4
R	19.	0.6	0.4	0.4
Bk	11.9	0.2	3.0	0.3
R	7.6	0.5	1.3	0.4

Subject #2

FAR	MEAN	Std. Dev.	F(time)	F(day)
Bk	40.	0	0	0
R	31.1	0.2	1.7	0.3
Bk	8.9	0.2	2.0	1.0
R	3.5	0.5	2.88	0.6
NEAR				
Bk	40	0	0	0
R	30.1	0.25	1.2	0.3
Bk	15.8	0.5	1.0	0.4
R	11.2	0.3	0.8	0.3

Subject #3

FAR	MEAN	Std. Dev.	F(time)	F(day)
Bk	22	0	2.1	2.1
R	16.6	1.1	3.0	0.7
Bk	8.7	0.2	0.6	1.0
R	2.6	0.6	3.3	0.8
NEAR				
Bk	25.4	0.5	1.9	2.9
R	19.4	0.6	1.6	0.3
Bk	12.0	0	0.3	1.0
R	6.0	0.4	0.5	0.5

Subject #4

FAR	MEAN	Std. Dev.	F(time)	F(day)
Bk	17.9	0.6	1.3	2.1
R	10.2	0.3	1.2	0.4
Bk	8.8	0.2	0.2	1.3
R	1.9	1.4	1.5	2.5
NEAR				
Bk	21.8	0.3	0.4	1.2
R	15.2	0.1	0.2	0.6
Bk	11.8	0.3	1.8	1.8
R	3.0	2.1	3.7	2.3

Subject #5

FAR	MEAN	Std. Dev.	F(time)	F(day)
Bk	25.5	1.1	3.6	1
R	19.9	0.2	0	0
Bk	6.7	0.9	3.1	1.4
R	2.6	0.9	3.6	1.1
NEAR				
Bk	16.0	0	3.82	1.9
R	11.0	0.8	3.18	1.1
Bk	16.0	0.2	0.2	0.6
R	11.5	0.7	3.2	2.5

Subject #6

FAR	MEAN	Std. Dev.	F(time)	F(day)
Bk	20.1	0.5	1.9	3.6
R	11.0	0.6	0.9	1.3
Bk	8.2	0.4	0.6	0.6
R	4.0	0.4	1.5	1.5
NEAR				
Bk	23.2	0.9	2.4	0.2
R	14.9	0.2	1.0	1.3
Bk	11.8	0.5	0.3	1.0
R	6.1	0.8	1.7	0.2

Subject #7

FAR	MEAN	Std. Dev.	F(time)	F(day)
Bk	23.5	0.4	0.5	1.5
R	8.2	1.0	3.6	3.0
Bk	8.8	0.4	2.6	2.6
R	3.0	1.0	3.2	1.6
NEAR				
Bk	22.8	1.2	2.7	1.3
R	15.6	0.9	2.7	1.8
Bk	11.6	0.5	0.3	1.0
R	6.0	0.7	1.7	3.3

Subject #8

FAR	MEAN	Std. Dev.	F(time)	F(day)
Bk	21.2	0.5	0.6	1.0
R	11.4	0.8	1.5	0.5
Bk	9.1	0.8	2.7	0.3
R	3.9	0.8	1.2	0.1
NEAR				
Bk	23	1.4	2.3	0.2
R	15.6	1.4	2.6	3.1
Bk	17.0	0.9	2.5	0
R	12.6	0.4	0.5	1.0

Subject #9

FAR	MEAN	Std. Dev.	F(time)	F(day)
Bk	23.4	0.8	3.2	0.4
R	11.1	0.2	3.5	1.0
Bk	8.1	0.6	2.0	1.0
R	3.3	0.4	0.5	0.1
NEAR				
Bk	23.8	1.9	2.3	0.2
R	16.0	0.7	2.6	3.1
Bk	15.8	0.3	2.5	0
R	11.0	0.4	0.5	1.0

Subject #10

FAR	MEAN	Std. Dev.	F(time)	F(day)
Bk	11.6	0.9	3.72	1.32
R	6.2	1.0	3.18	0.3
Bk	7.7	0.8	3.3	0.8
R	3.4	0.4	3.4	0.4
NEAR				
Bk	17.6	0.7	2.0	1.0
R	10.5	0.4	0.7	0.7
Bk	17.8	0.5	2.0	1.0
R	11.5	0.4	1.0	2.0

Subject #11

FAR	MEAN	Std. Dev.	F(time)	F(day)
Bk	15.4	0.5	2.6	1.6
R	4.5	0.7	0.9	3.0
Bk	4.4	0.4	2.7	1.0
R	1.3	0.5	1.3	0.5
NEAR				
Bk	20.2	0.3	0.6	0.6
R	9.5	0.7	1.8	1.2
Bk	16.0	0	1.0	1.0
R	7.9	1.0	1.6	1.6

Subject #12

FAR	MEAN	Std. Dev.	F(time)	F(day)
Bk	16.4	0.5	1.1	0.5
R	10.0	0.7	1.5	1.5
Bk	8.1	0.1	1.0	1.0
R	3.6	0.1	0	0.6
NEAR				
Bk	24.1	0.2	0.6	0.6
R	15.5	0.4	0.7	0.7
Bk	20.1	0.2	0.6	0.6
R	13.8	0.9	1.7	0.2

DISCUSSION OF RESULTS

To determine the significance of the variations found in the study, an analysis procedure had to be used which should enable the treatment of data to ascertain day to day variation and long term variation (four week survey). Two way analysis of variance seemed to be the most logical test of significance that was available which would allow analysis of data in more than one mode. The method treats the data for significance by analyzing the change occurring in each day's run and then the significance of change occurring over a four week period of time for each subject. The F test of significance is generally used in conjunction with the two way analysis of variance.

Appendix A-L (A is subject #1; B is subject #2, etc.) contain all raw data which was obtained from the study and these are the figures which were used for the analysis of data.

Pacific University computer center has the analysis of two way variance available for use with the terminals by students. The data from the Appendix was typed into the computer terminal and the analysis was done by the computer.

The tables of data obtained are listed in the results of the paper. The results are tabulated in exactly the same sequence that they were taken i.e. Far Base Out (B.O.) break and recovery (BK and R) Base In (B.I.) break and recovery (BK and R) and then the same results at 40 cm. (near point). Each table lists the mean of the total sample, the standard deviation, the F value for entire study F(time), and the F value for the time change during the day F(day).

The significance of the variation was based on the F distribution of 95% confidence level. The value in the tables for 9 degrees of freedom was 3.86.

SUMMARY

In summary, the lateral duction sequence is a group of tests which are used to define or structure an analysis scheme or schemes. Therefore, it is mandatory that these tests be relatively non-variable and have a high degree of reproducibility. The study concludes that the duction sequence is definitely a good reproducible group of tests with little variability beyond the chance variance and the equipment induced errors; that is, prism distortion which could influence the judgement of an individual from one day to another or from one test to another. No significant variance was shown to exist between near and far findings or between B.O. and B.I. findings. A high correlation of intertest stability was found to be present no matter how the findings were considered. Additional studies with longer time intervals and greater sample size would be a valuable follow up. Clinically, the findings of the study are important because the duction sequence is a very necessary group of tests for the optometrist to rely on when testing initially, or when retesting after some therapy has been prescribed.

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SUBJECT ONE

		DAY ONE BREAK /	RECOVERY	DAY TWO BREAK /	RECOVERY	DAY THREE BREAK /	RECOVERY	DAY FOUR BREAK /	RECOVERY
Far	B.O.	24	16	24	15	24	16	24	15
	B.I.	9	6	9	6	9	6	9	6
Near	B.O.	26	20	26	20	26	20	26	20
	B.I.	12	8	12	8	12	8	12	8
Far	B.O.	24	16	24	16	24	16	24	14
	B.I.	9	4	9	6	9	4	9	5
Near	B.O.	24	18	24	18	26	20	26	18
	B.I.	12	6	12	8	10	6	12	8
Far	B.O.	24	18	26	16	22	12	24	16
	B.I.	9	4	9	5	9	4	10	6
Near	B.O.	24	18	26	20	24	16	24	20
	B.I.	12	8	12	8	12	8	12	8
Far	B.O.	22	16	26	15	24	14	22	14
	B.I.	8	4	9	4	8	4	9	4
Near	B.O.	26	18	26	20	26	18	26	20
	B.I.	12	6	12	8	12	8	12	8

SUBJECT TWO

		DAY ONE BREAK / RECOVERY		DAY TWO BREAK / RECOVERY		DAY THREE BREAK / RECOVERY		DAY FOUR BREAK / RECOVERY	
Far	B.O.	40	30	40	32	40	32	40	30
	B.I.	9	4	9	3	9	3	9	3
Near	B.O.	40	30	40	30	40	30	40	30
	B.I.	16	12	16	12	16	10	16	12
Far	B.O.	40	32	40	30	40	30	40	32
	B.I.	9	4	9	2	9	3	9	2
Near	B.O.	40	30	40	30	40	30	40	30
	B.I.	16	10	16	12	16	12	16	10
Far	B.O.	40	32	40	30	40	30	40	30
	B.I.	8	4	9	4	9	4	9	4
Near	B.O.	40	30	40	30	40	30	40	30
	B.I.	16	10	12	10	16	12	16	12
Far	B.O.	40	30	40	32	40	34	40	32
	B.I.	8	4	9	3	9	3	9	4
Near	B.O.	40	30	40	32	40	30	40	30
	B.I.	16	12	16	12	16	12	16	10

SUBJECT THREE

		DAY ONE BREAK / RECOVERY		DAY TWO BREAK / RECOVERY		DAY THREE BREAK / RECOVERY		DAY FOUR BREAK / RECOVERY	
Far	B.O.	22	18	22	18	22	18	22	16
	B.I.	9	2	9	2	9	2	9	2
Near	B.O.	26	20	26	20	26	20	26	20
	B.I.	12	6	12	6	12	6	12	6
Far	B.O.	22	16	20	16	22	18	20	14
	B.I.	9	2	9	2	9	3	9	4
Near	B.O.	26	18	26	20	26	20	26	20
	B.I.	12	6	12	6	12	6	12	8
Far	B.O.	20	16	22	16	22	18	20	16
	B.I.	8	2	9	2	9	3	8	4
Near	B.O.	24	18	24	20	24	18	26	20
	B.I.	12	6	12	4	12	8	12	4
Far	B.O.	18	14	22	18	22	18	20	16
	B.I.	8	2	8	4	9	2	8	4
Near	B.O.	24	18	24	18	26	20	26	20
	B.I.	12	6	12	6	12	6	12	6

SUBJECT FOUR

		DAY ONE BREAK / RECOVERY		DAY TWO BREAK// RECOVERY		DAY THREE BREAK / RECOVERY		DAY FOUR BREAK / RECOVERY	
Far	B.O.	18	10	18	10	18	10	18	10
	B.I.	9	2	9	1	9	1	9	1
Near	B.O.	22	15	22	15	22	15	22	16
	B.I.	12	2	12	4	12	1	12	1
Far	B.O.	18	10	18	10	18	10	18	10
	B.I.	9	4	9	0	9	1	9	2
Near	B.O.	22	16	22	14	22	15	20	14
	B.I.	12	4	10	6	12	2	12	2
Far	B.O.	18	10	16	12	18	10	18	12
	B.I.	9	2	9	2	9	0	9	0
Near	B.O.	20	16	22	14	22	16	22	14
	B.I.	12	2	12	8	10	2	12	2
Far	B.O.	20	10	16	10	18	10	18	10
	B.I.	8	2	9	1	9	2	9	2
Near	B.O.	22	14	22	16	22	15	22	16
	B.I.	12	4	12	6	12	2	12	0

SUBJECT FIVE

		DAY ONE BREAK / RECOVERY		DAY TWO BREAK / RECOVERY		DAY THREE BREAK / RECOVERY		DAY FOUR BREAK / RECOVERY	
Far	B.O.	26	20	24	20	26	30	26	20
	B.I.	6	2	8	4	6	2	6	2
Near	B.O.	21	18	20	16	21	18	21	16
	B.I.	11	2	16	10	16	12	16	12
Far	B.O.	26	20	24	20	26	20	26	20
	B.I.	6	2	8	4	6	2	6	4
Near	B.O.	22	18	20	16	24	16	20	14
	B.I.	16	10	16	10	16	12	16	10
Far	B.O.	26	20	24	20	26	20	24	18
	B.I.	6	2	8	4	8	4	6	2
Near	B.O.	22	18	20	16	22	16	20	16
	B.I.	16	10	16	10	16	10	14	10
Far	B.O.	26	20	24	20	28	20	26	20
	B.I.	6	2	8	4	6	0	6	2
Near	B.O.	20	18	20	16	24	18	20	14
	B.I.	16	12	16	10	16	4	18	12

SUBJECT SIX

		DAY ONE BREAK / RECOVERY		DAY TWO BREAK / RECOVERY		DAY THREE BREAK / RECOVERY		DAY FOUR BREAK / RECOVERY	
Far	B.O	20	10	20	12	20	10	20	12
	B.I.	8	4	8	4	8	4	8	4
Near	B.O.	24	16	22	16	24	16	24	16
	B.I.	12	6	12	8	12	6	12	6
Far	B.O.	20	10	18	12	20	10	20	10
	B.I.	8	4	8	2	8	4	8	4
Near	B.O.	24	14	24	16	24	14	24	14
	B.I.	12	4	14	8	10	4	12	6
Far	B.O.	20	10	20	10	22	14	20	10
	B.I.	8	4	8	4	10	6	8	4
Near	B.O.	22	14	20	14	22	14	24	14
	B.I.	12	6	10	6	12	6	12	6
Far	B.O.	22	12	20	12	20	12	20	10
	B.I.	8	4	8	4	8	4	8	4
Near	B.O.	24	16	22	14	24	14	24	16
	B.I.	12	6	12	6	10	6	12	8

SUBJECT SEVEN

		DAY ONE BREAK / RECOVERY		DAY TWO BREAK / RECOVERY		DAY THREE BREAK / RECOVERY		DAY FOUR BREAK / RECOVERY	
Far	B.O.	24	6	24	8	24	8	24	8
	B.I.	9	2	9	2	9	4	9	2
Near	B.O.	24	18	24	16	24	16	24	16
	B.I.	12	4	12	4	10	6	12	4
Far	B.O.	14	6	24	8	24	8	22	8
	B.I.	9	4	9	3	9	4	9	4
Near	B.O.	24	18	24	16	22	16	24	16
	B.I.	12	8	12	8	10	8	12	6
Far	B.O.	24	8	24	10	24	10	24	8
	B.I.	9	2	9	2	8	4	9	2
Near	B.O.	24	16	24	14	20	14	22	14
	B.I.	12	6	12	3	12	6	12	6
Far	B.O.	24	8	20	10	22	10	24	8
	B.I.	9	2	6	3	10	6	8	2
Near	B.O.	22	16	20	10	22	14	24	14
	B.I.	12	6	10	6	10	6	12	4

SUBJECT EIGHT

		DAY ONE BREAK	DAY ONE RECOVERY	DAY TWO BREAK	DAY TWO RECOVERY	DAY THREE BREAK	DAY THREE RECOVERY	DAY FOUR BREAK	DAY FOUR RECOVERY
Far	B.O.	22	12	22	12	20	10	22	12
	B.I.	6	4	9	4	8	4	9	4
Near	B.O.	24	18	24	18	22	16	24	12
	B.I.	18	14	18	15	16	14	18	14
Far	B.O.	20	14	20	12	20	10	22	10
	B.I.	10	6	9	3	8	2	8	4
Near	B.O.	24	14	24	16	20	16	24	12
	B.I.	16	12	16	14	16	10	18	10
Far	B.O.	20	12	22	10	24	12	22	10
	B.I.	9	4	9	4	8	4	8	2
Near	B.O.	24	18	22	16	22	14	22	12
	B.I.	18	12	16	10	16	12	18	12
Far	B.O.	22	12	20	10	20	12	22	12
	B.I.	9	4	10	6	8	4	8	2
Near	B.O.	24	16	22	16	20	14	24	14
	B.I.	18	14	16	12	16	12	18	14

SUBJECT NINE

		DAY ONE BREAK / RECOVERY		DAY TWO BREAK / RECOVERY		DAY THREE BREAK / RECOVERY		DAY FOUR BREAK /RECOVERY	
Far	B.O.	24	10	24	10	22	10	24	10
	B.I.	8	4	8	4	6	4	8	4
Near	B.O.	24	16	26	18	22	18	26	18
	B.I.	16	10	16	10	16	12	16	12
Far	B.O.	24	12	22	12	24	12	22	12
	B.I.	8	2	8	2	6	2	9	5
Near	B.O.	24	18	24	16	22	16	24	18
	B.I.	16	12	16	10	16	10	16	10
Far	B.O.	24	10	22	10	24	12	22	12
	B.I.	9	4	8	4	6	4	8	4
Near	B.O.	24	14	26	16	20	16	24	14
	B.I.	14	12	16	12	16	12	16	10
Far	B.O.	24	12	24	12	24	12	22	10
	B.I.	8	2	8	4	6	2	8	2
Near	B.O.	24	12	26	16	20	16	24	14
	B.I.	16	12	16	8	14	10	16	12

SUBJECT TEN

		DAY ONE BREAK / RECOVERY		DAY TWO BREAK / RECOVERY		DAY THREE BREAK / RECOVERY		DAY FOUR BREAK / RECOVERY	
Far	B.O.	12	6	12	6	12	8	12	6
	B.I.	8	4	8	4	6	2	8	4
Near	B.O.	14	10	18	10	18	12	18	10
	B.I.	18	12	18	12	18	12	18	12
Far	B.O.	10	6	12	6	12	8	10	4
	B.I.	8	4	8	4	6	4	8	3
Near	B.O.	18	12	16	10	18	10	16	12
	B.I.	18	12	18	12	18	12	18	10
Far	B.O.	12	6	12	6	12	6	10	4
	B.I.	9	2	8	4	6	2	8	4
Near	B.O.	18	10	18	10	18	10	16	10
	B.I.	18	12	18	12	18	10	18	10
Far	B.O.	12	8	14	6	12	8	10	6
	B.I.	8	4	8	4	8	4	8	2
Near	B.O.	18	8	16	10	18	10	16	12
	B.I.	18	10	18	12	18	12	18	12

SUBJECT ELEVEN

		DAY ONE BREAK	DAY ONE RECOVERY	DAY TWO BREAK	DAY TWO RECOVERY	DAY THREE BREAK	DAY THREE RECOVERY	DAY FOUR BREAK	DAY FOUR RECOVERY
Far	B.O.	16	4	16	4	16	4	16	4
	B.I.	6	2	4	2	4	0	4	2
Near	B.O.	20	8	20	8	20	10	20	8
	B.I.	16	6	16	6	16	8	16	6
Far	B.O.	14	2	16	2	16	4	16	6
	B.I.	6	2	4	2	4	1	6	2
Near	B.O.	22	10	20	8	20	10	20	10
	B.I.	16	10	16	6	16	8	16	6
Far	B.O.	16	6	14	4	14	6	16	8
	B.I.	6	2	4	0	4	0	4	2
Near	B.O.	20	10	22	10	20	12	20	10
	B.I.	16	8	16	8	16	10	16	10
Far	B.O.	16	6	14	6	14	8	16	4
	B.I.	6	2	4	1	4	2	4	0
Near	B.O.	20	10	20	10	20	10	20	8
	B.I.	16	8	16	6	16	8	16	8

SUBJECT TWELVE

		DAY ONE BREAK / RECOVERY		DAY TWO BREAK / RECOVERY		DAY THREE BREAK / RECOVERY		DAY FOUR BREAK / RECOVERY	
Far	B.O.	16	10	16	10	16	10	16	10
	B.I.	8	2	8	4	8	4	8	4
Near	B.O.	24	16	24	16	24	16	24	16
	B.I.	20	14	20	14	20	14	20	14
Far	B.O.	16	10	16	12	16	10	18	12
	B.I.	8	4	8	4	8	4	8	4
Near	B.O.	24	14	24	16	24	16	24	14
	B.I.	20	14	20	14	20	12	20	12
Far	B.O.	16	8	16	10	18	12	16	8
	B.I.	8	4	8	2	8	2	8	4
Near	B.O.	24	16	24	14	24	16	24	18
	B.I.	20	16	22	16	20	12	20	12
Far	B.O.	16	8	16	10	18	10	16	10
	B.I.	8	4	8	4	8	4	8	2
Near	B.O.	26	16	24	14	24	16	24	14
	B.I.	20	14	20	14	20	14	20	14